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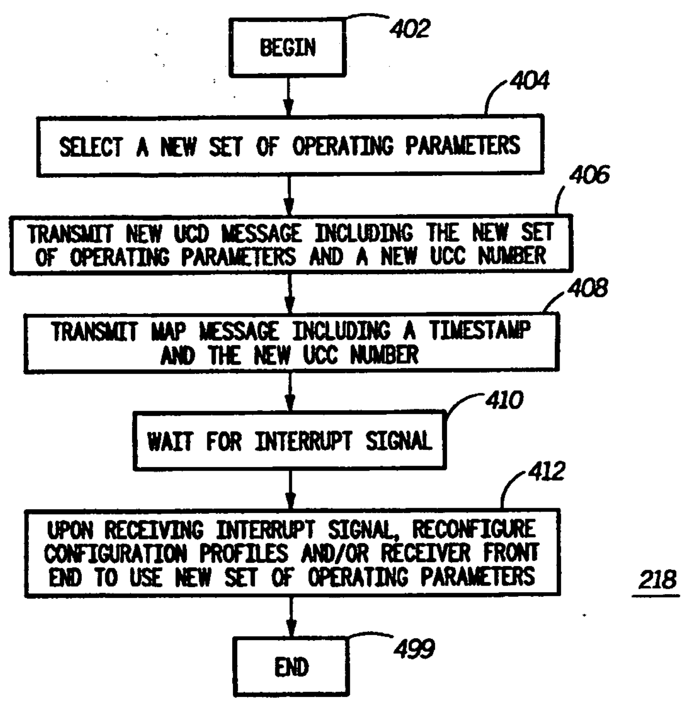
(54) Title: SYSTEM, DEVICE, AND METHOD FOR RECONFIGURING OPERATING PARAMETERS IN A COMMUNICATION NETWORK

(57) Abstract

A system, device, and method for reconfiguring operating parameters in a shared medium communication network selects a new set of operating parameters (404), and schedules a switch over time at which to begin using the new set of operating parameters. A reconfiguration time is determined (412), where the reconfiguration time is a fixed predetermined amount of time prior to the switch over time. An interrupt (410) is generated at the reconfiguration time to initiate reconfiguration of the operating parameters.



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SYSTEM, DEVICE, AND METHOD FOR RECONFIGURING OPERATING PARAMETERS IN A COMMUNICATION NETWORK

Background

1. Field of the Invention

The invention relates generally to communication systems, and more particularly to reconfiguring operating parameters in a shared medium communication network.

2. Discussion of Related Art

In today's information age, there is an increasing need for high-speed communication networks that provide Internet access and other on-line services for an ever-increasing number of communications consumers. To that end, communications networks and technologies are evolving to meet current and future demands. Specifically, new networks are being deployed which reach a larger number of end users, and protocols are being developed to utilize the added bandwidth of these networks efficiently.

One technology that has been widely employed and will remain important in the foreseeable future is the shared medium communication network. A shared medium communication network is one in which a single communications channel (the shared channel) is shared by a number of users such that uncoordinated transmissions from different users may interfere with one another. The shared medium communication network typically includes a number of secondary stations that transmit on the shared channel, and a single primary station situated at a common receiving end of the shared channel for receiving the secondary station transmissions. Since

communication networks typically have a limited number of communication channels, the shared medium communication network allows many users to gain access to the network over a single communication channel, thereby allowing the remaining communication channels to be used for other purposes.

One problem in a shared medium communication network involves managing the shared channel to enable user transmissions over the shared channel. This involves not only scheduling transmission opportunities for the secondary station transmissions, but also selecting an appropriate set of operating parameters for the shared channel. Typical operating parameters include a channel center frequency, a modulation mode, and a number of encoding parameters. The operating parameters are used by each secondary station for transmitting on the shared channel, and are also used by a primary station for receiving the secondary station transmissions.

The selection of such operating parameters depends on a number of factors such as channel quality and traffic loading. These factors often change over time due to changing channel impairments and traffic patterns. Therefore, it may become necessary or desirable to change the set of operating parameters based on the changing channel impairments, traffic patterns, and other factors.

Each change of the operating parameters requires careful coordination between the primary station and the secondary stations, and also within the primary station itself. Specifically, each change of the operating parameters is scheduled to take effect at a particular time, and both the primary station and the secondary stations must begin using the changed operating parameters in a synchronized manner. Within the primary station itself, the change of operating parameters often occurs between secondary station transmissions, so

that the primary station must be able to receive one secondary station transmission using one set of operating parameters and receive a subsequent secondary station transmission using the changed set of operating parameters. The primary station often receives secondary station transmissions in quick succession, and therefore the primary station often has little time to reconfigure itself between secondary station transmissions. Thus, the primary station typically includes complex logic for changing operating parameters. Simplified logic for changing operating parameters is therefore desirable.

Brief Description of the Drawing

In the Drawing,

FIG. 1 is a block diagram showing an exemplary shared medium communication network in accordance with a preferred embodiment of the present invention;

FIG. 2 is a block diagram showing an exemplary primary station in accordance with a preferred embodiment of the present invention;

FIG. 3 is time-line showing the time sequence involved in reconfiguring the operating parameters in accordance with a preferred embodiment of the present invention;

FIG. 4 is a flow diagram showing exemplary MAP Logic for switching over to a new set of operating parameters in accordance with a preferred embodiment of the present invention;

FIG. 5 is a flow diagram showing exemplary MAC Logic for switching over to a new set of operating parameters in accordance with a preferred embodiment of the present invention; and

FIG. 6 is a block diagram of an integrated circuit device implementing MAC Logic in accordance with a preferred embodiment of the present invention.

Detailed Description

FIG. 1 shows a shared medium communication network 100 in accordance with a preferred embodiment of the present invention. The shared medium communication network 100 allows a number of end users 110_1 through 110_N to access a remote external network 108 such as the Internet. The shared medium communication network 100 acts as a conduit for transporting information between the end users 110 and the external network 108.

The shared medium communication network 100 includes a primary station 102 that is coupled to the external network 108. The primary station 102 is in communication with a plurality of secondary stations 104_1 through 104_N (collectively referred to as "secondary stations 104" and individually as a "secondary station 104") by means of channels 106 and 107. Channel 106 carries information in a "downstream" direction from the primary station 102 to the secondary stations 104, and is hereinafter referred to as "downstream channel 106." Channel 107 carries information in an "upstream" direction from the secondary stations 104 to the primary station 102, and is hereinafter referred to as "upstream channel 107." Each end user 110 interfaces to the shared medium communication network 100 by means of a secondary station 104.

In a preferred embodiment, the shared medium communication network 100 is a data-over-cable (DOC) communication system wherein the downstream channel 106 and the upstream channel 107 are separate channels carried over a shared physical medium. In the preferred embodiment, the shared physical medium is a hybrid fiber-optic and coaxial cable (HFC) network. The downstream channel 106 is one of a plurality of downstream channels carried over the HFC

network. The upstream channel 107 is one of a plurality of upstream channels carried over the HFC network. In other embodiments, the shared physical medium may be coaxial cable, fiber-optic cable, twisted pair wires, and so on, and may also include air, atmosphere, or space for wireless and satellite communication. Also, the various upstream and downstream channels may be the same physical channel, for example, through time-division multiplexing/duplexing, or separate physical channels, for example, through frequency-division multiplexing/duplexing.

In the shared medium communication network 100 of the preferred embodiment, the downstream channels, including the downstream channel 106, are typically situated in a frequency band above approximately 50 MHz, although the particular frequency band may vary from system to system, and is often country-dependent. The downstream channels are classified as broadcast channels, since any information transmitted by the primary station 102 over a particular downstream channel, such as the downstream channel 106, reaches all of the secondary stations 104. Any of the secondary stations 104 that are tuned to receive on the particular downstream channel can receive the information.

In the shared medium communication network 100 of a preferred embodiment, the upstream channels, including the upstream channel 107, are typically situated in a frequency band between approximately 5 through 42 MHz, although the particular frequency band may vary from system to system, and is often country-dependent. The upstream channels are classified as shared channels, since only one secondary station 104 can successfully transmit on a particular upstream channel at any given time, and therefore the upstream channels must be shared among the plurality of secondary stations

104. If more than one of the secondary stations 104 simultaneously transmit on a particular upstream channel, such as the upstream channel 107, there is a collision that corrupts the information from all of the simultaneously transmitting secondary stations 104.

In order to allow multiple secondary stations 104 to share a particular upstream channel, such as the upstream channel 107, the primary station 102 and the secondary station 104 participate in a medium access control (MAC) protocol. The MAC protocol provides a set of rules and procedures for coordinating access by the secondary station 104 to the shared upstream channel 107. Each secondary station 104 participates in the MAC protocol on behalf of its end users. For convenience, each participant in the MAC protocol is referred to as a "MAC User."

In a preferred embodiment, the MAC protocol is a protocol commonly referred to as Multimedia Cable Network System (MCNS). In the preferred embodiment, the MAC protocol divides the upstream channel 107 into successive time slots. The MAC protocol supports a plurality of slot types for carrying different types of information. Each time slot is capable of transporting a unit of information (for example, a data packet or a control packet). The primary station 102 assigns each time slot to a particular MAC User or group of MAC Users. A MAC User that has data to transmit is permitted to transmit only in time slots designated by the primary station 102. A MAC User transmission must begin and end within a designated time slot to avoid corrupting transmissions by other MAC Users in other time slots.

The MAC protocol also defines a set of operating parameters for the upstream channel 107. The operating parameters include a channel center frequency, a modulation mode, a modulation symbol rate, a modulation preamble sequence, and a number of encoding

parameters. The secondary station 104 uses the set of operating parameters when transmitting user data and control information on the upstream channel 107. The primary station 104 uses the set of operating parameters to recover the user data and control information received on the upstream channel 107.

Before the secondary station 104 can transmit data and control information to the primary station 102 over the upstream channel 107, the primary station 102 and the secondary station 104 must have a common set of operating parameters. The primary station 102 selects a set of operating parameters that are appropriate for the upstream channel 107. The primary station 102 then sends the selected set of operating parameters to the secondary station 104 by means of a special control message (referred to as an "Upstream Channel Descriptor" or "UCD" message) transmitted on the downstream channel 106. The UCD message includes the selected set of operating parameters, and further includes an Upstream Configuration Count (UCC) field that uniquely identifies the UCD message from other UCD messages previously or subsequently transmitted to the secondary station 104.

Thereafter, the primary station schedules transmission opportunities for the secondary station 104 by regularly transmitting special control messages (referred to as "MAP" messages) to the secondary station 104 by means of the downstream channel 106. Each MAP message provides an assignment of transmission opportunities for a predetermined number of successive time slots. Each MAP message includes, among other things, a timestamp indicating the start time of the first time slot, a slot type indicator and MAC User assignment for each of the successive time slots, and a

UCC number uniquely identifying a set of operating parameters to be used by the secondary station 104.

FIG. 2 is a block diagram showing an exemplary primary station 102 in accordance with a preferred embodiment of the present invention. In the preferred embodiment, the primary station 102 includes a number of functional modules implemented on individual cards that fit within a common chassis. In order to enable communication within the shared medium communication network 100, the primary station 102 requires at least a minimum set of functional modules. Specifically, the minimum set of functional modules comprises an Adapter Module 210, a MAC Module 220, a Transmitter Module 240, and a Receiver Module 230. In the preferred embodiment, the minimum set of functional modules allows the primary station 102 to support a single downstream channel and up to eight upstream channels. For the sake of convenience and simplicity, the exemplary embodiments described below refer to the single upstream channel 107, although it will be apparent to a skilled artisan that multiple upstream channels are supportable in a similar manner.

The Adapter Module 210 controls the flow of data and control messages between the primary station 102 and the secondary stations 104. The Adapter Module 210 includes MAP Logic 218 that is coupled to a Memory 212. The Memory 212 is divided into a Dedicated Memory 216 that is used only by the MAP Logic 218, and a Shared Memory 214 that is shared by the MAP Logic 218 and MAC Logic 224 (described below) for exchanging data and control messages. The MAP Logic 218 includes, among other things, logic for selecting the set of operating parameters for the upstream channel 107, and logic for generating UCD and MAP messages. The MAP Logic 218 stores the UCD and MAP messages in a MAC Transmit Queue (not shown)

in the Shared Memory 214, and stores data messages in a Data Transmit Queue (not shown) in the Shared Memory 214.

The MAC Module 220 implements MAC functions within the primary station 102. The MAC Module 220 includes MAC Logic 224 that is coupled to a Local Memory 222 and to the Shared Memory 214 by means of interface 250. The MAC Logic 224 monitors the MAC Transmit Queue and the Data Transmit Queue in the Shared Memory 214. The MAC Logic 224 transmits any queued data and control (UCD and MAP) messages to Encoder/Modulator 241 of Transmitter Module 240 by means of interface 253. The MAC Logic 224 also processes data and control messages received from the Receiver Module 230 by means of interface 255. The MAC Logic 224 stores the received data and control messages in a Receive Queue (not shown) in the Shared Memory 214 by means of interface 250.

The Transmitter Module 240 provides an interface to the downstream channel 106 for transmitting data and control (UCD and MAP) messages to the secondary station 104. The Transmitter Module 240 includes a Transmitter Front End 242 that is operably coupled to the downstream channel 106 and an Encoder/Modulator 241. The Encoder/Modulator 241 includes logic for receiving and processing data and control (UCD and MAP) messages from the MAC Logic 224 by means of interface 253. More specifically, the Encoder/Modulator 241 includes encoding logic for encoding the data and control (UCD and MAP) messages according to a predetermined set of encoding parameters, and modulating logic for modulating the encoded data and control (UCD and MAP) messages according to a predetermined modulation mode. The Transmitter Front End 242 includes logic for transmitting the modulated signals from the Encoder/Modulator 241 onto the downstream channel 106. More

specifically, the Transmitter Front End 242 includes tuning logic for tuning to a downstream channel 106 center frequency, and filtering logic for filtering the transmitted modulated signals. Both the Encoder/Modulator 241 and the Transmitter Front End 242 include adjustable parameters, including downstream channel center frequency for the Transmitter Front End 242, and modulation mode, modulation symbol rate, and encoding parameters for the Encoder/Modulator 241.

The Receiver Module 230 provides an interface to the upstream channel 107 for receiving, among other things, data and control messages from the secondary station 104. The Receiver Module 230 includes a Receiver Front End 232 that is operably coupled to the upstream channel 107 and to a Demodulator/Decoder 231. The Receiver Front End 232 includes logic for receiving modulated signals from the upstream channel 107. More specifically, the Receiver Front End 232 includes tuning logic for tuning to an upstream channel 107 center frequency, and filtering logic for filtering the received modulated signals. The Demodulator/Decoder 231 includes logic for receiving and processing the filtered modulated signals from the Receiver Front End 232. More specifically, the Demodulator/Decoder 231 includes demodulating logic for demodulating the modulated signals according to a predetermined modulation mode, and decoding logic for decoding the demodulated signals according to a predetermined set of decoding parameters to recover data and control information from the secondary station 104. Both the Receiver Front End 232 and the Demodulator/Decoder 231 include adjustable parameters, including upstream channel center frequency for the Receiver Front End 232, and modulation mode, modulation symbol rate, modulation preamble

sequence, and decoding parameters for the Demodulator/Decoder 231.

In the preferred embodiment, the primary station 102 includes a configuration interface 254 through which the adjustable parameters on both the Receiver Module 230 and the Transmitter Module 240 are configured. The configuration interface 254 operably couples the MAC Logic 224 to the Demodulator/Decoder 231, the Receiver Front End 232, the Encoder/Modulator 241, and the Transmitter Front End 242. The configuration interface 254 is preferably a Serial Peripheral Interface (SPI) bus as is known in the art.

The MAC Logic 224 includes logic that enables the MAP Logic 218 to configure the adjustable parameters on both the Receiver Module 230 and the Transmitter Module 240. The MAP Logic 218 sends configuration commands by means of interface 251, and the MAC Logic 224 forwards the configuration commands to the Receiver Module 230 and the Transmitter Module 240 by means of configuration interface 254. For convenience, this forwarding of configuration commands by the MAC Logic 224 is referred to as a "pass-through function."

In the preferred embodiment, the pass-through function is used for configuring parameters in the Receiver Front End 232, the Encoder/Modulator 241, and the Transmitter Front End 242, but is not used for configuring parameters in the Demodulator/Decoder 231. Instead, the MAC Logic 224 directly configures the parameters in the Demodulator/Decoder 231 based on a number of configuration profiles provided by the MAP Logic 218. More specifically, the MAP Logic 218 defines a configuration profile for each of the plurality of slot types supported by the MAC protocol, and sends the configuration profiles to the MAC Logic 224 by means of interface 251. The MAC Logic 224

stores the configuration profiles in the Local Memory 222. The MAC Logic 224 dynamically reconfigures the Demodulator/Decoder 231, on a slot-by-slot basis if necessary, so that the Demodulator/Decoder 231 uses the correct set of parameters for each slot according to the slot type designated by the MAP Logic 218 in MAP messages.

During operation of the MAC protocol, it may become necessary or desirable for the primary station 102 to change the operating parameters for the upstream channel 107. For example, the primary station 102 may change the upstream channel center frequency or any of the modulation and/or encoding parameters in response to changing upstream channel conditions. The switch over to a new set of operating parameters is carefully coordinated so that both the primary station 102 and the secondary station 104 begin using the new set of operating parameters on the same time slot. If the switch over to the new set of configuration parameters is not synchronized, then the primary station 102 will receive corrupted data and control information.

In order to change the operating parameters for the upstream channel 240, the MAP Logic 218 selects a new set of operating parameters and transmits a new UCD message to the secondary station 104. The new UCD message includes the new set of operating parameters, and further includes a new UCC number uniquely identifying the new set of operating parameters. In a preferred embodiment, the new UCC number is incremented each time the upstream configuration parameters are changed.

Upon receiving the new UCD message including the new UCC number, the secondary station 104 stores the new set of operating parameters and the new UCC number. However, the secondary station 104 does not begin to use the new set of operating parameters

immediately. Instead, the secondary station 104 continues using the same set of operating parameters until explicitly informed by the primary station 102 to switch to the new set of operating parameters.

Some time after transmitting the new UCD message to the secondary station 104, the MAP Logic 218 determines a time slot at which to switch over to the new set of operating parameters (referred to hereinafter as the "switch over time"). The MAP Logic 218 informs the primary stations 104 of the switch over time by transmitting a MAP message including the new UCC number. In a preferred embodiment, both the primary station 102 and the secondary station 104 switch over to the new set of operating parameters on the first time slot as indicated by the timestamp in the MAP.

Upon receiving a MAP message including the new UCC number, the secondary station 104 prepares to switch over to the new set of operating parameters. At the time designated by the timestamp in the MAP, the secondary station 104 reconfigures its transmitter to use the new set of operating parameters. The new set of operating parameters is used for transmitting on the upstream channel 107 until another such UCD change occurs.

Likewise, the primary station 102 prepares to switch over to the new set of operating parameters. Depending on which parameters were changed, the primary station 102 must reconfigure the configuration profiles maintained by the MAC Logic 224 and/or the Receiver Front End 232 parameters. In order for the primary station 102 to properly receive the secondary station 104 transmissions, the parameters cannot be configured too far in advance of the switch over time or after the switch over time.

In a typical embodiment, the MAP Logic 218 is implemented in software as a set of program instructions executed by a

microprocessor. Therefore, synchronization of the MAP Logic 218 is often accomplished using a software-based timer. The software-based timer is typically derived from a system clock or from a timer provided by the operating system or other component in the primary station 102.

Such software-based timers are generally not well-suited for timing the switch over to the new set of configuration parameters. Software-based timers are typically synchronized to a system clock and not to the MAC protocol, and therefore may not provide a precise indication of the switch over time. Because of this, the MAP Logic 218 may require additional logic to synchronize reconfiguration of the configuration profiles and/or the Receiver Front End 232.

Another complicating factor is that the MAP Logic 218 must actually begin reconfiguring the configuration profiles and/or the Receiver Front End 232 parameters prior to the actual switch over time. This is because the software reconfiguration must be completed before the actual switch over time. Therefore, the MAP Logic 218 must determine an appropriate time to begin reconfiguring the configuration profiles and/or the Receiver Front End 232 (referred to hereinafter as the "reconfiguration time"). An efficient technique for determining both the switch over time and the reconfiguration time is needed.

The preferred embodiment provides an efficient technique for determining an appropriate reconfiguration time. When the MAP Logic 218 schedules a switch over to a new set of operating parameters, the MAP Logic 218 creates a new MAP message including a timestamp and a new UCC number, as described above. The MAP Logic 218 schedules transmission of the MAP message by storing the MAP message in the MAC Transmit Queue in the Shared Memory 214.

The MAC Logic 224, which monitors the MAC Transmit Queue, transmits the MAP message, and also examines the contents of the MAP message to determine the start time of the first slot (based on the timestamp), the slot type designations, and the UCC number. The timestamp and the slot type designations enable the MAC Logic 224 to determine the correct configuration profile for each slot so that the MAC Logic 224 can dynamically reconfigure the Demodulator/Decoder 231. The UCC number enables the MAC Logic 224 to determine whether the MAP Logic 218 has scheduled a switch over to a new set of operating parameters. Specifically, the MAC Logic 224 determines that the MAP Logic 218 has scheduled a switch over to a new set of operating parameters if the UCC number in the MAP message has been incremented (i.e., the UCC number in the MAP message is equal to the new UCC number).

When the MAC Logic 224 determines that the MAP Logic 218 has scheduled a switch over to a new set of operating parameters, based on the UCC number in the MAP message, the MAC Logic 224 determines the switch over time based on the timestamp in the MAP message. The MAC Logic 224 also determines the reconfiguration time prior to the switch over time. In the preferred embodiment, the reconfiguration time is a fixed predetermined amount of time before the switch over time, preferably one millisecond. The MAC Logic 224 signals the MAP Logic 218 at the reconfiguration time by sending an interrupt signal to the MAP Logic 218 by means of interrupt signal 252.

Upon receiving the interrupt signal 252, the MAP Logic 218 reconfigures the configuration profiles and/or the Receiver Front End 232 to use the new set of operating parameters. Because the interrupt signal 252 occurs prior to the actual switch over time, the MAP Logic 218 has sufficient time to reconfigure the operating parameters. Also,

the reconfiguration is synchronized with the switch over by the secondary station 104 without the MAP Logic 218 having to use a software-based timer.

FIG. 3 is a time-line showing the time sequence involved in reconfiguring the operating parameters on the upstream channel 107. The MAP Logic 218 first generates a new UCD message including a new set of operating parameters and a new UCC number, in step 302. The MAC Logic 224 transmits the new UCD message to the secondary stations 104, in step 304. Subsequently, the MAP Logic 218 generates a MAP message including a timestamp and the new UCC number, in step 306. The MAC Logic 224 transmits the MAP message to the secondary stations 104, in step 308. Based on the timestamp in the MAP message, the MAC Logic 224 determines a switch over time and a reconfiguration time and sends an interrupt signal to the MAP Logic 218 at the reconfiguration time, in step 310. Upon receiving the interrupt signal, the MAP Logic 218 reconfigures the configuration profiles in step 312 and/or the Receiver Front End 232 in step 314. Subsequently, the MAC Logic 224 dynamically reconfigures the Demodulator/Decoder 231 in step 316 according to the reconfigured configuration profiles.

FIG. 4 is a flow diagram showing MAP Logic 218 for switching over to a new set of operating parameters. The logic begins in step 402, and proceeds to select a new set of operating parameters, in step 404. The logic then transmits a new UCD message in step 406. The new UCD message includes the new set of operating parameters and a new UCC number. Subsequently, the logic transmits a MAP message in step 408. The MAP message includes a timestamp indicating the switch over time, and also includes the new UCC number. The logic waits for an interrupt signal in step 410, and upon

receiving the interrupt signal, proceeds to reconfigure the configuration profiles and/or the Receiver Front End 232 to use the new set of operating parameters in step 412. The logic terminates in step 499.

FIG. 5 is a flow diagram showing MAC Logic 224 for switching over to a new set of operating parameters. The logic begins in step 502, and proceeds to receive a MAP message, in step 504. The MAP message includes a new UCC number indicating that a switch over to the new set of operating parameters has been scheduled, and includes a timestamp indicating the switch over time. The logic determines the switch over time based on the timestamp in step 506, and determines the reconfiguration time based on the switch over time in step 508. The logic sends an interrupt signal to the MAP Logic 218 at the reconfiguration time, in step 510. The logic terminates in step 599.

It will be apparent to a skilled artisan that the MAC Logic 224 can be embodied using discrete components, integrated circuitry, programmable logic used in conjunction with a programmable logic device such as a Field Programmable Gate Array (FPGA) or microprocessor, or any other means including any combination thereof. Programmable logic can be fixed temporarily or permanently in a tangible medium such as a read-only memory chip, a computer memory, a disk, or other storage medium. Programmable logic can also be fixed in a computer data signal embodied in a carrier wave, allowing the programmable logic to be transmitted over an interface such as a computer bus or communication network. All such embodiments are intended to fall within the scope of the present invention.

Thus, one embodiment of MAC Logic 224 is a device that includes logic for receiving a signal (i.e., the MAP message) indicating

a switch over to a new set of operating parameters, the signal including a timestamp indicating a switch over time; logic for determining the switch over time based on the timestamp; logic for determining a reconfiguration time prior to the switch over time; and logic for generating an interrupt signal at the reconfiguration time. In the preferred embodiment, the MAC Logic 224 is embodied in hardware, and particularly as an integrated circuit device 600 as shown in FIG. 6. The integrated circuit device 600 of the preferred embodiment includes an input 602 that is operably coupled to the interface 250 for receiving, among other things, MCNS MAP messages. Each MAP message includes a timestamp and an identification number. Examining logic 604, operably coupled to the input 602, examines the identification number in each MAP message to determine whether the MAP message indicates a switch over to a new set of operating parameters. Determining logic 606 determines a switch over time based on the timestamp in the MAP message, and also determines a reconfiguration time prior to the switch over time. Interrupt generating logic 610 utilizes a clock 608 to delay until the reconfiguration time, and generates an interrupt signal at the reconfiguration time by means of an output 612. Output 612 is operably coupled to the interrupt signal 252 for sending an interrupt to the MAP Logic 218 along the interrupt signal 252.

In the preferred embodiment, the integrated circuit device 600 supports up to eight independent upstream channels. Therefore, the integrated circuit device 600 maintains separate configuration profiles for each of the up to eight independent upstream channels, and monitors for configuration changes on a channel-by-channel basis. If a MAP message indicates a configuration change for any one of the upstream channels, the integrated circuit device 600 determines the

switch over time and reconfiguration time for the affected channel, and generates an interrupt signal at the reconfiguration time.

In the preferred embodiment, the MAP Logic 218 is implemented in software that includes logic for selecting a set of operating parameters; logic for transmitting a first message (i.e., the new UCD message) including the set of operating parameters and an identification number (i.e., the new UCC number); logic for subsequently transmitting a second message (i.e., the MAP message) including a timestamp and the identification number; logic for waiting for an interrupt signal; and logic for reconfiguring the operating parameters upon receiving the interrupt signal. However, it will be apparent to a skilled artisan that the MAP Logic 218 can be embodied using discrete components, integrated circuitry, programmable logic used in conjunction with a programmable logic device such as a Field Programmable Gate Array (FPGA) or microprocessor, or any other means including any combination thereof. Programmable logic can be fixed temporarily or permanently in a tangible medium such as a read-only memory chip, a computer memory, a disk, or other storage medium. Programmable logic can also be fixed in a computer data signal embodied in a carrier wave, allowing the programmable logic to be transmitted over an interface such as a computer bus or communication network. All such embodiments are intended to fall within the scope of the present invention.

The present invention is particularly desirable because it simplifies the design of the primary station 102 and provides the MAP Logic 218 with a precise indication of the reconfiguration time based on the scheduled switch over time. Thus, an embodiment of the present invention is a device (i.e., primary station 102) that includes first logic (i.e., MAP Logic 218) for selecting a set of operating

parameters; transmitting a first message (i.e., the new UCD message) including the set of operating parameters and an identification number (i.e., the new UCC number); subsequently transmitting a second message (i.e., the MAP message) including a timestamp and the identification number; waiting for an interrupt signal; and reconfiguring the operating parameters upon receiving the interrupt signal; and second logic (i.e., MAC Logic 224), responsive to the first logic, for receiving the second signal (i.e., the MAP message); determining a switch over time based on the timestamp; determining a reconfiguration time based on the switch over time; and generating the interrupt signal at the reconfiguration time.

Consequently, the present invention as embodied in the primary station 102 provides an overall benefit to the shared medium communication network 100 as a whole. By simplifying the primary station 102 and allowing the primary station 102 to precisely time its reconfiguration of the operating parameters, the shared medium communication network 100 is better able to provide reliable upstream communications. Thus, an embodiment of the present invention is a system that includes a primary station in communication with a number of secondary stations, wherein the primary station includes first logic (i.e., MAP Logic 218) for selecting a set of operating parameters; transmitting a first message (i.e., the new UCD message) including the set of operating parameters and an identification number (i.e., the new UCC number); subsequently transmitting a second message (i.e., the MAP message) including a timestamp and the identification number; waiting for an interrupt signal; and reconfiguring the operating parameters upon receiving the interrupt signal; and second logic (i.e., MAC Logic 224), responsive to the first logic, for receiving the second signal (i.e., the MAP message); determining a

switch over time based on the timestamp; determining a reconfiguration time based on the switch over time; and generating the interrupt signal at the reconfiguration time.

The present invention may be embodied in other specific forms without departing from the essence or essential characteristics. The described embodiments are to be considered in all respects only as illustrative and not restrictive.

I claim:

1. A method for signaling a time for reconfiguring operating parameters in a communication network, the method characterized by the steps of:

receiving a signal indicating a switch over to a new set of operating parameters, the signal including a timestamp indicating a switch over time;

determining the switch over time based on the timestamp;

determining a reconfiguration time prior to the switch over time; and

generating an interrupt signal at the reconfiguration time.

2. The method of claim 1 wherein the reconfiguration time is a fixed predetermined amount of time prior to the switch over time.

3. The method of claim 1 wherein the signal is received in conjunction with a Medium Access Control (MAC) protocol.

4. The method of claim 3 wherein the MAC protocol is a Multimedia Cable Network System (MCNS) protocol and wherein the signal is a MAP message as utilized in the MCNS protocol.

5. A device for signaling a time for reconfiguring operating parameters in a communication network, the device characterized by:

receiving logic operably coupled to receive a signal indicating a switch over to a new set of operating parameters, the signal including a timestamp indicating a switch over time;

first determining logic operably coupled to receive the timestamp from the receiving logic and to determine the switch over time based on the timestamp;

second determining logic operably coupled to receive the switch over time from the first determining logic and to determine a reconfiguration time prior to the switch over time; and

interrupt generating logic operably coupled to receive the reconfiguration time from the second determining logic and to generate an interrupt signal at the reconfiguration time.

6. The device of claim 5 wherein the reconfiguration time is a fixed predetermined amount of time prior to the switch over time.

7. The device of claim 5 wherein the signal is received in conjunction with a Medium Access Control (MAC) protocol.

8. The device of claim 7 wherein the MAC protocol is a Multimedia Cable Network System (MCNS) protocol and wherein the signal is a MAP message as utilized in the MCNS protocol.

9. The device of claim 5 further characterized by:

means for receiving a signal indicating a switch over to a new set of operating parameters, the signal including a timestamp indicating a switch over time;

means for determining the switch over time based on the timestamp;

means for determining a reconfiguration time prior to the switch over time; and

means for generating an interrupt signal at the reconfiguration time.

10. A device characterized by:

first logic selecting a new set of operating parameters, transmitting a first message including the new set of operating parameters and an identification number, subsequently transmitting a second message including a timestamp and the identification number, waiting for an interrupt signal, and reconfiguring the operating parameters upon receiving the interrupt signal; and

second logic responsive to the first logic, the second logic receiving the second message, determining a switch over time based on the timestamp, determining a reconfiguration time based on the switch over time, and generating the interrupt signal at the reconfiguration time.

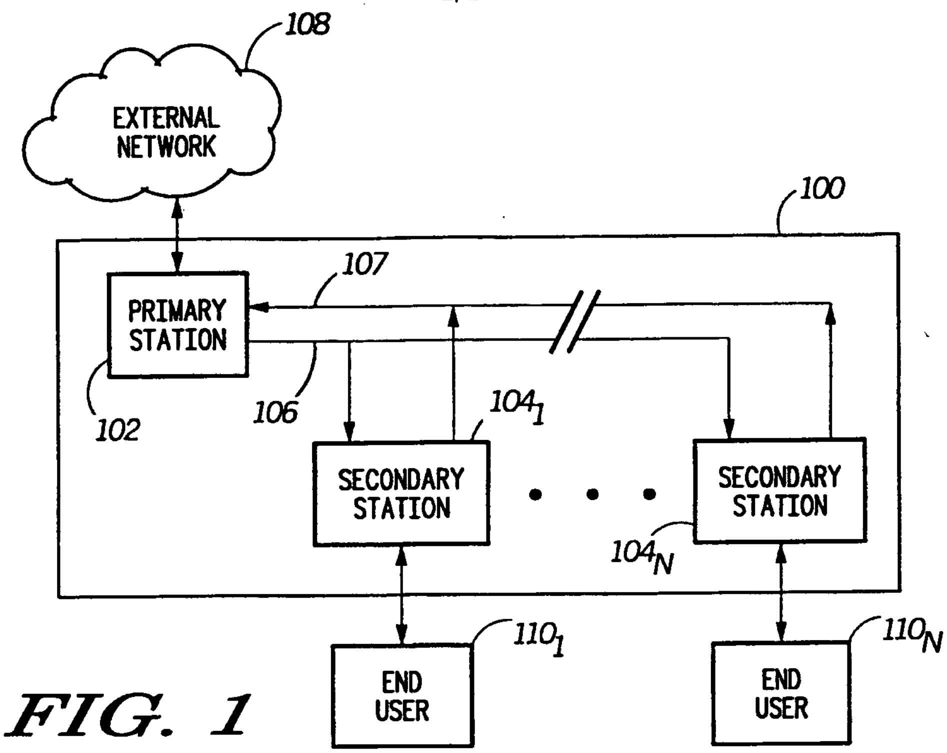
108
EXTERNAL NETWORK
100
107
PRIMARY STATION
102
106
104_1
SECONDARY STATION
SECONDARY STATION
104_N
110_1
END USER
110_N
END USER

FIG. 1

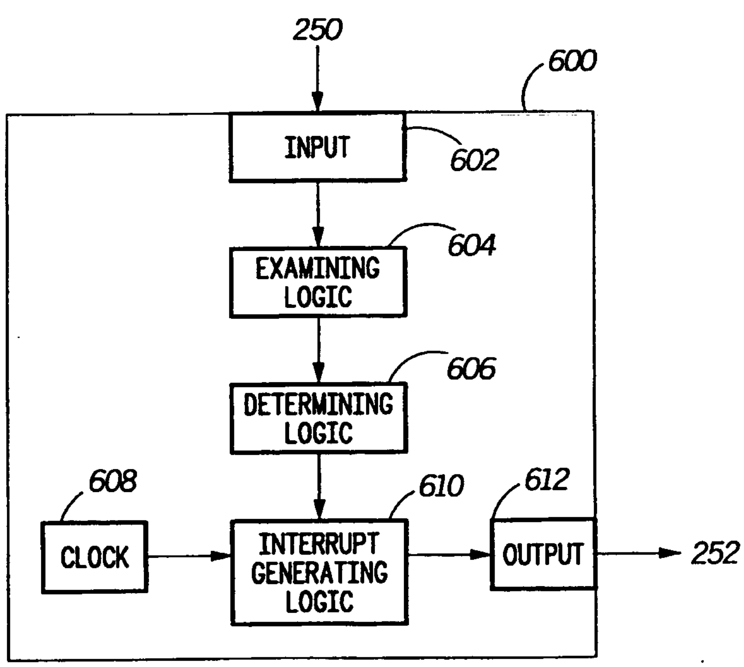
250
600
INPUT
602
EXAMINING LOGIC
604
DETERMINING LOGIC
606
608
CLOCK
610
INTERRUPT GENERATING LOGIC
612
OUTPUT
252

FIG. 6

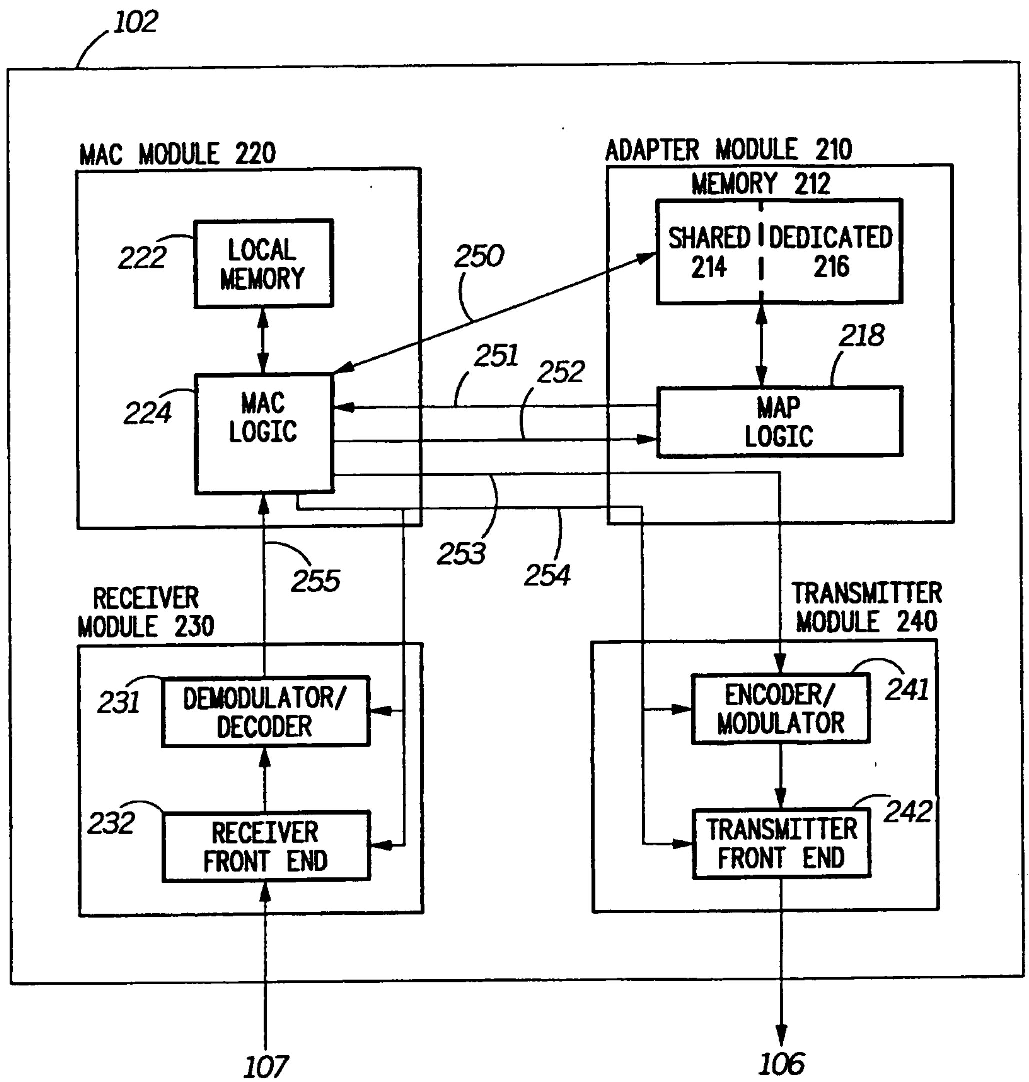
102
MAC MODULE 220
222
LOCAL MEMORY
224
MAC LOGIC
ADAPTER MODULE 210
MEMORY 212
SHARED 214
DEDICATED 216
218
MAP LOGIC
250
251
252
253
254
255
RECEIVER MODULE 230
231
DEMODULATOR/ DECODER
232
RECEIVER FRONT END
TRANSMITTER MODULE 240
ENCODER/ MODULATOR
241
TRANSMITTER FRONT END
242
107
106

FIG. 2

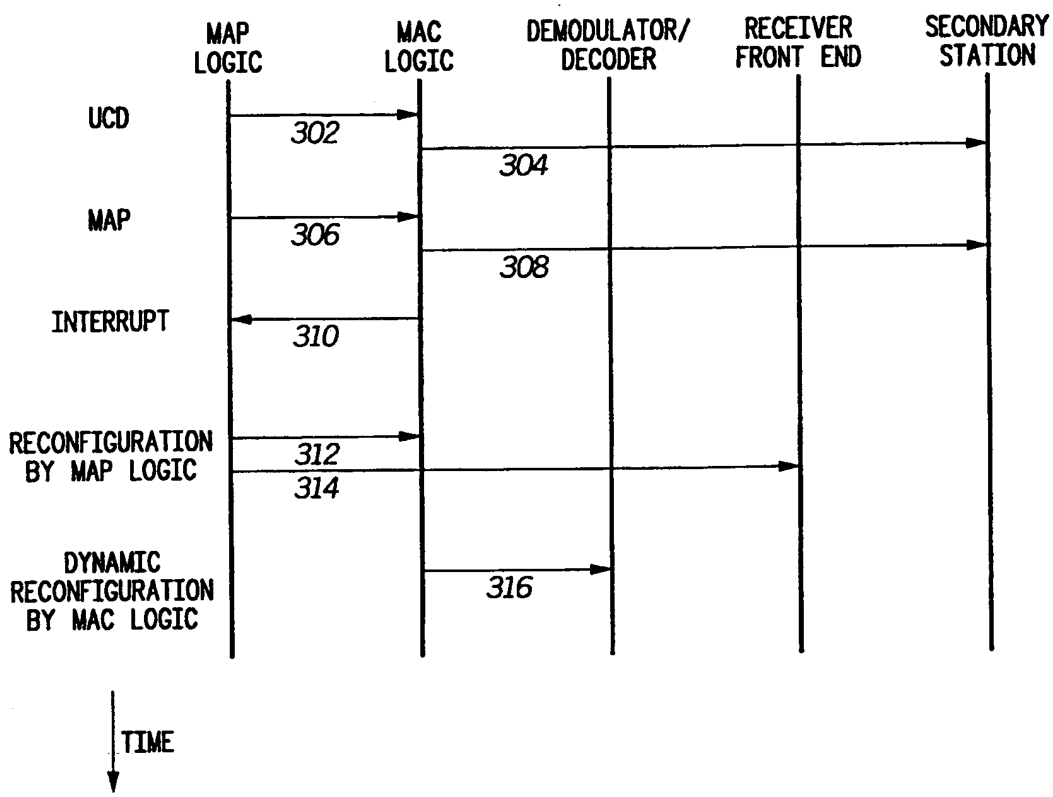
MAP LOGIC
MAC LOGIC
DEMODULATOR/ DECODER
RECEIVER FRONT END
SECONDARY STATION
UCD
302
304
MAP
306
308
INTERRUPT
310
RECONFIGURATION BY MAP LOGIC
312
314
DYNAMIC RECONFIGURATION BY MAC LOGIC
316
TIME

FIG. 3

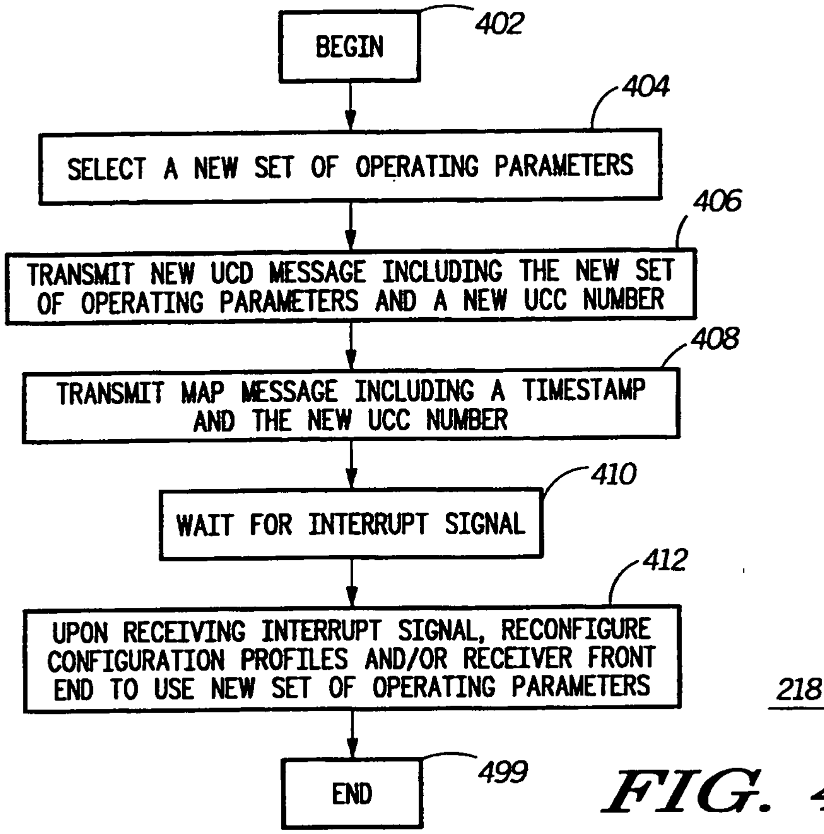
BEGIN
402
SELECT A NEW SET OF OPERATING PARAMETERS
404
TRANSMIT NEW UCD MESSAGE INCLUDING THE NEW SET OF OPERATING PARAMETERS AND A NEW UCC NUMBER
406
TRANSMIT MAP MESSAGE INCLUDING A TIMESTAMP AND THE NEW UCC NUMBER
408
WAIT FOR INTERRUPT SIGNAL
410
UPON RECEIVING INTERRUPT SIGNAL, RECONFIGURE CONFIGURATION PROFILES AND/OR RECEIVER FRONT END TO USE NEW SET OF OPERATING PARAMETERS
412
218
END
499

FIG. 4

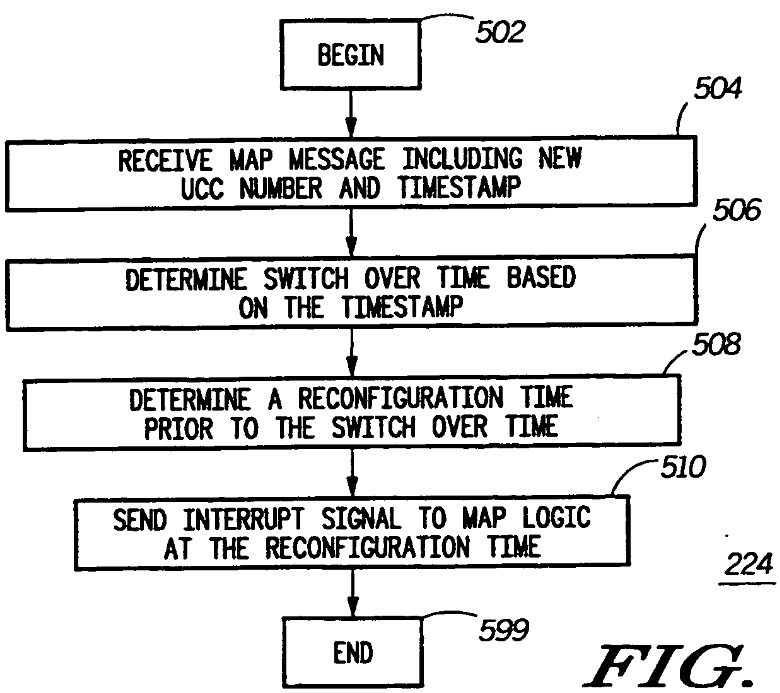
BEGIN
502
RECEIVE MAP MESSAGE INCLUDING NEW UCC NUMBER AND TIMESTAMP
504
DETERMINE SWITCH OVER TIME BASED ON THE TIMESTAMP
506
DETERMINE A RECONFIGURATION TIME PRIOR TO THE SWITCH OVER TIME
508
SEND INTERRUPT SIGNAL TO MAP LOGIC AT THE RECONFIGURATION TIME
510
224
END
599

FIG. 5

INTERNATIONAL SEARCH REPORT	International application No. PCT/US99/07842

A. CLASSIFICATION OF SUBJECT MATTER

IPC(6) :H04N 7/10; H04H 1/00; H04J 3/12
US CL :348/6, 7, 8, 9, 10, 11, 12; 455/5.1; 370/410, 522
According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

U.S. : 348/6, 7, 8, 9, 10, 11, 12; 455/5.1; 370/410, 522

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	US 5,572,517 A (SAFADI et al) 05 NOVEMBER 1996, See abstract, Col 2, lines 56 to col 3, line 5 and cols 3-4, lines 40-36.	1-10

☐ Further documents are listed in the continuation of Box C. ☐ See patent family annex.

*	Special categories of cited documents:
"A"	document defining the general state of the art which is not considered to be of particular relevance
"E"	earlier document published on or after the international filing date
"L"	document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)
"O"	document referring to an oral disclosure, use, exhibition or other means
"P"	document published prior to the international filing date but later than the priority date claimed
"T"	later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention
"X"	document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone
"Y"	document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art
"&"	document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
10 JUNE 1999	22 JUL 1999

Name and mailing address of the ISA/US	Authorized officer
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